

## DISTRIBUTION AND ABUNDANCE OF PELAGIC FISHES IN THE EPIPELAGIC LAYERS OF THE INDIAN SECTOR OF THE SOUTHERN OCEAN IN SUMMER, 1983–84

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**Abstract:** R. V. KAIYO MARU collected pelagic fishes with KYMT and ORI-200 net in the upper 100m layers of the Indian Sector of the Southern Ocean during the period from December 1983 to February 1984. More than 20 species and 150 specimens were recorded, of which the mesopelagic fishes comprised about 87% of the total catch. Differences in species composition and abundance were observed between waters north of 56°S and south of 61°S. Abundance expressed by the number of specimens per 1000m<sup>3</sup> water volume filtered was as high as 0.125 in the KYMT and 0.250 in the ORI-200 net in waters south of 61°S between 65 and 75°E. The area where the fish were absent agreed with the area where the cold water masses were prevailing in the waters south of 61°S in January and February 1984.

### 1. Introduction

During the austral summer from December 1983 to February 1984, R. V. KAIYO MARU, Japanese Fisheries Agency, made biological and oceanographic survey in the Indian Sector of the Southern Ocean as part of the SIBEX I program. The main purpose of the present survey was to gain information about the size and distribution of krill biomass. Samples collected with two kinds of nets contained pelagic fishes together with other zooplankton. This paper deals with the distribution and abundance of pelagic fishes in the upper 100m layer in the area investigated during the krill biomass survey in the austral summer of 1983–84.

Concerning the fishes in the Indian Sector of the Southern Ocean, the species, distributional patterns, and fisheries resources are discussed by various authors (NAFPAKTITIS and NAFPAKTITIS, 1969; DEWITT, 1971; YUKOV, 1972; EVERSON, 1977; NAFPAKTITIS, 1978; MEISNER and KRATKII, 1978; ANDRIASHEV, 1980; DUHAMEL *et al.*, 1983; WILLIAMS, 1983; GULLAND, 1983). The data on the larval and juvenile fishes, however, have not yet been published.

### 2. Materials and Methods

The waters along the 75°E meridian from 46 to 61°S latitude and the area south of 61°S latitude between 65 and 75°E longitude were surveyed in December 1983 (Survey I), and the latter area was again surveyed in January–February 1984 (Survey II)

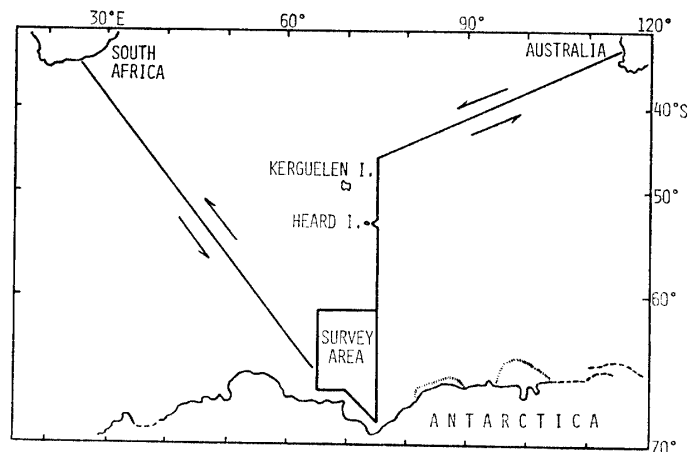


Fig. 1. Map showing the 75°E meridian and survey area during the SIBEX I cruise of R. V. KAIYO MARU.

(Fig. 1). From the observation of the surface isotherms it was obvious that the Antarctic Polar Front had a distinctive identity between 55 and 56°S, south of Heard Island, during the season. Pack ice margins were observed around 63–64°S in Survey I, while they were observed further south (around 67–69°) in Survey II.

Krill and other zooplankton were collected with KYMT (KAIYO MARU midwater trawl, mouth size 3×3 m, net length 16 m, mesh aperture 3.4 mm) and ORI-200 net (Ocean Research Institute 200 net, mouth diameter 1.6 m, net length 8.7 m, mesh aperture 2.0 mm) equipped with a depth recorder and a flow meter. The nets were towed obliquely by paying out 300 m of cable at a speed of 3 kn. The actual depths the nets reached were 75–135 m ( $99.8 \pm 17.0$  m) in the KYMT and 50–110 m ( $93.9 \pm 13.2$  m) in the ORI-200 net samplings. Number of hauls with each net is shown in Table 1. The present fishes were sorted from the samples collected with both nets mentioned above.

Table 1. Number of oblique hauls of the KYMT and ORI-200 net in Surveys I (December 1983) and II (January–February 1984).

Nets	Number of hauls		
	Survey I	Survey II	Total
KYMT	44	40	84
ORI-200	33	33	66
Total	77	73	150

### 3. Results

Table 2 shows the occurrences and counts of the fishes taken in oblique tows of the KYMT and ORI-200 net in Surveys I and II. The fishes represented more than 20 species and 150 specimens in total, of which the mesopelagic fishes belonging to the families Myctophidae (ca. 10 species and 98 specimens) and Paralepididae (*Notolepis coasti*, 28 specimens) occupied about 87%. From a viewpoint of developmental stages,

Table 2. Species composition and abundance of the fishes taken with the KYMT and ORI-200 net in Surveys I (December 1983) and II (January–February 1984).

Family	Species	Survey I			Survey II			Grand total
		KYMT	ORI-200	Total	KYMT	ORI-200	Total	
Myctophidae	<i>Protomyctophum</i> spp.	37		37	4		4	41
	<i>Electrona antarctica</i>	10	8	18	19	1	20	38
	<i>Electrona</i> spp.	7		7	2		2	9
	<i>Lampanyctus</i> sp.	8		8				8
	? <i>Hygophum</i> sp.		1	1				1
	Myctophidae sp.	1		1				1
Paralepididae	<i>Notolepis coasti</i>	8	3	11	15	2	17	28
Bothidae	<i>Mancopsetta maculata</i>	3	5	8				8
Channichthyidae	<i>Chaenocephalus</i> sp., etc.	1	2	3	2	1	3	6
Nototheniidae	<i>Notothenia</i> spp.		4	4				4
	<i>Pleuragramma antarcticum</i>				1		1	1
Muraenolepididae	<i>Muraenolepis</i> sp.	1	1	2				2
Bathylagidae	<i>Bathylagus</i> sp.	1		1				1
Clupeiformes	(damaged)	1		1				1
Unidentified		1		1				1
Grand total		79	24	103	43	4	47	150

Table 3. Number of specimens per 1000 m<sup>3</sup> water volume filtered with the KYMT and ORI-200 net in Surveys I and II. Hauls of long time duration for krill collections are excluded.

Survey No.		KYMT			ORI-200		
		No. of specimens collected	Water volume filtered (×1000m <sup>3</sup> )	No. of specimens /1000 m <sup>3</sup>	No. of specimens collected	Water volume filtered (×1000m <sup>3</sup> )	No. of specimens /1000 m <sup>3</sup>
Survey I	North of 60°S	50	118.0	0.424	15	19.5	0.769
	South of 61°S	25	200.1	0.125	12	48.2	0.250
Survey II		36	343.9	0.105	4	73.6	0.054

*Electrona antarctica* (38 specimens, 13–22 mm TL), *N. coasti* (28, 19–54), *Mancopsetta maculata* (8, 12–18), Channichthyidae (6, 17–60) and Nototheniidae (4, 13–20) are referable to the juvenile stage (ca. 60% of the total catch). Other fishes are young and adult of less than 10 cm in total length. The pelagic fish eggs belonging to 2 species (2 of 4.0 mm in diameter and 3 of 3.5 mm in diameter) were obtained with the KYMT in Survey I.

The KYMT samples of Survey I contained the greatest number (79 specimens) followed by the same net samples of Survey II (43 specimens), while the catch in the ORI-200 net was very low in both Surveys (24 and 4 specimens, respectively) (Table 2). However, the abundance of the fishes expressed by the number of specimens per 1000 m<sup>3</sup> water volume filtered (Table 3) was higher in the ORI-200 net (0.769 in the waters along 75°E from 46 to 61°S and 0.250 in the waters south of 61°S between 65 and 75°E) than in the KYMT (0.424 and 0.125, respectively) in Survey II.

Relative catch of the fishes with the KYMT (Fig. 2) showed that the abundance of the fishes was higher at the stations north of 56°S (mean 0.510 specimens/1000m<sup>3</sup>) than at the stations south of 61°S (0.122 specimens/1000m<sup>3</sup> in Survey I and 0.158 specimens/1000m<sup>3</sup> in Survey II). The same occurrence of the fishes was seen in the catch with the ORI-200 net (0.822 specimens/1000m<sup>3</sup> at the stations north of 56°S, and 0.208 in Survey I and 0.056 specimens/1000m<sup>3</sup> in Survey II at the stations south of 61°S). The most prominent occurrence was seen at a station at 47°59.5'S, 74°59.0'E, where *Myctophidae* (5 species and 26 specimens), *M. maculata* (1 specimen), unidentified juvenile (1 specimen) and young squids (2 species and 4 specimens) were caught with the KYMT in Survey I. In Survey II, the majority of occurrence of fishes was confined to the northern stations, of which only the station at 63°57.1'S, 74°58.3'E was remarkable in catch (3 species and 13 specimens). No fish was collected from the stations in the central area surveyed (Fig. 2).

Based on the distributional patterns by species, the fishes collected were classified into three groups. The fish of the first group (*M. maculata*) occurred in the waters north of the Antarctic Polar Front. The bothid juveniles were collected only at the

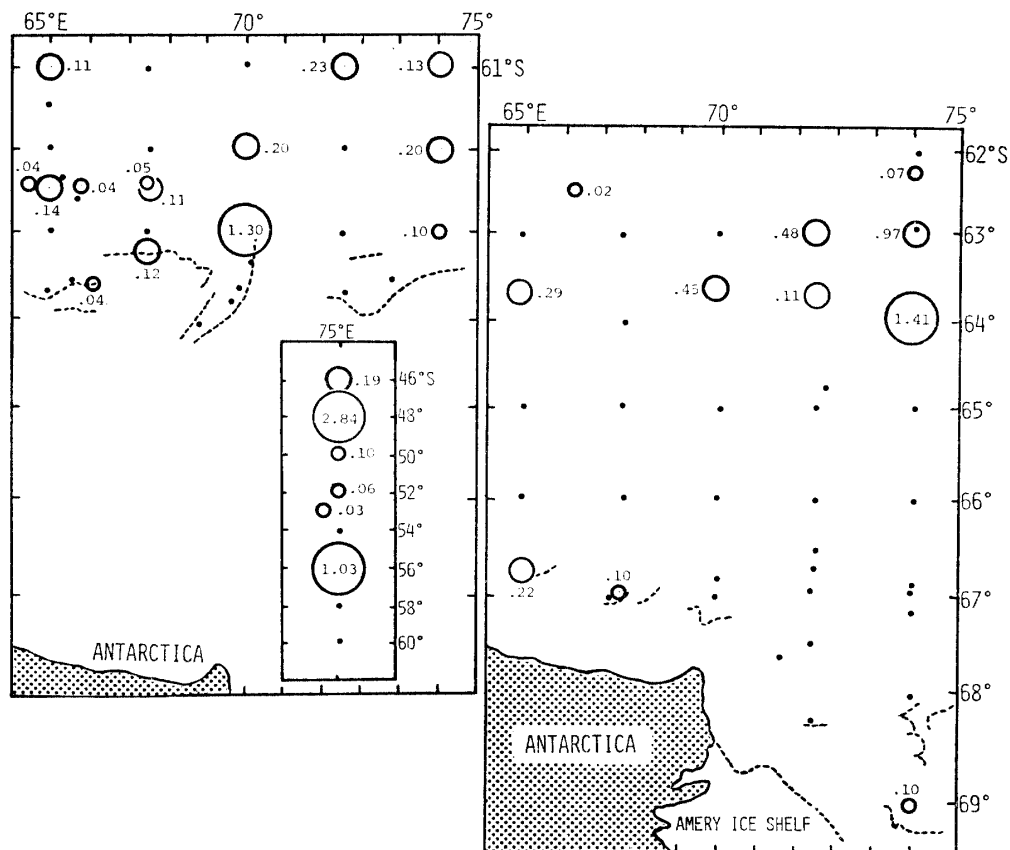


Fig. 2. Relative occurrences of the fishes collected with the KYMT in Survey I (December 1983, left) and Survey II (January–February 1984, right). Small open circle, less than 0.10 specimens/1000m<sup>3</sup>; middle open circle, 0.10–1.00 specimens/1000m<sup>3</sup>; large open circle, more than 1.00 specimens/1000m<sup>3</sup> of water volume filtered. Numerals indicate the actual numbers of specimens per 1000m<sup>3</sup> observed. Small solid circles represent the negative stations. Dotted lines indicate the pack ice margins observed.

stations north of 50°S. Besides this fish, epipelagic eggs referable to notothenioid occurred in the shallow waters around Heard Island north of the Front. The fishes of the second group (*E. antarctica* and *N. coasti*) occurred in the waters south of 61°S. These two dominant juveniles (Table 2) had an obvious trend of wide distribution in the surveyed area south of 61°S between 65 and 75°E. Differences in species composition as well as abundance of the fishes previously mentioned were observed between north of 56°S and south of 61°S. The fishes of the third group (Channichthyidae, Nototheniidae and most of Myctophidae) occurred in both areas. According to the distributions of the adult fishes belonging to this group (ANDRIASHEV, 1965; DEWITT, 1971; EVERSON, 1977), reexamination of their distributional patterns in the species levels is indispensable for precise classification.

As seen from Table 2, the number of fishes obtained in Survey II (47 specimens) was less than a half that in Survey I (103 specimens). However, in the waters of 61–63°S between 65 and 75°E, where both Survey I (December 1983) and II (January–February 1984) were made at intervals of 1.0–1.5 months, 3 species and 27 specimens were obtained from the 11 stations out of the 34 stations examined in Survey I, while 4 species and 34 specimens were obtained from the 8 stations out of the 15 stations examined in Survey II with the KYMT. Figure 3 shows the total length frequencies of *E. antarctica* in December 1983 and January–February 1984, indicating almost the same mean length in both seasons (17 and 18 mm TL, respectively).

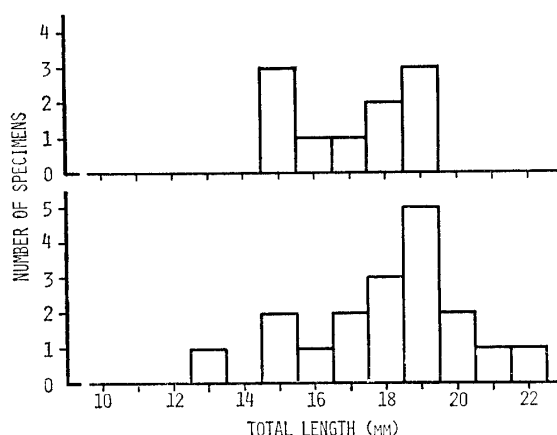


Fig. 3. Total length frequencies of *Electrona antarctica* collected in Survey I (10 specimens, upper) and Survey II (18 specimens, lower).

#### 4. Discussion

The present survey demonstrated the abundance and diversity of the pelagic fishes of more than 12 mm in total length in the upper 100 m layers of the Indian Sector of the Southern Ocean in the summer of 1983–84, though the larval and juvenile fishes of less than 11 mm in total length were excluded because of their escape from the KYMT and ORI-200 net. The highest value (0.240 specimens/1000 m<sup>3</sup> with the ORI-200 net, KOMAKI, unpublished) observed in the area of 61–67°S between 30 and 80°E from December 1980 to February 1981 on board KAIYO MARU is comparable to 0.250 specimens/1000 m<sup>3</sup> with the ORI-200 net in the area south of 61°S in the present Survey I (Table 3). The values observed in the epipelagic layers of the Indian Sector of the

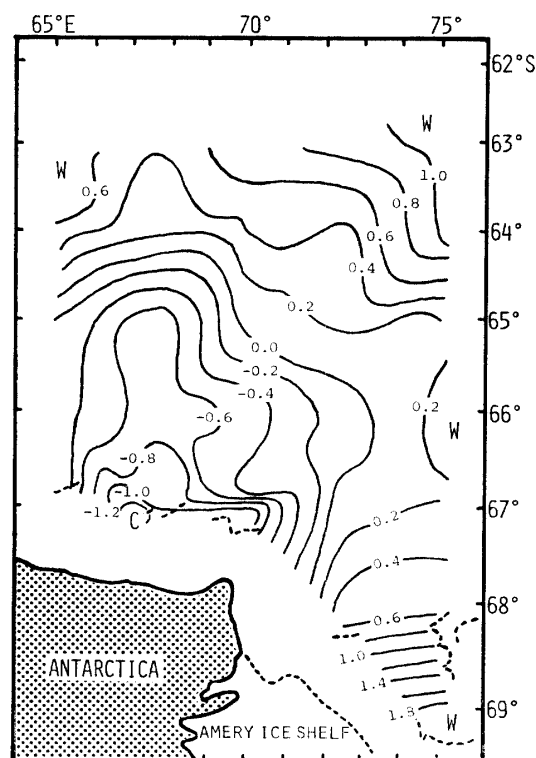


Fig. 4. Isotherms at the 10 m depth in January–February 1984.  
C: cold water mass, W: warm water mass.

Southern Ocean are in striking contrast with the rich mesopelagic fish fauna at 670–1050 m (mean 841 m) depth observed with 10 feet IKMT in the Southern Ocean south of Australia in the same season (MIYA *et al.*, 1986).

Differences in species composition and abundance of the fishes observed between north of 56°S and south of 61°S were apparently a reflection of the oceanographic conditions in relation to the Antarctic Polar Front which was identified between 55 and 56°S as stated before. No fish was collected at the stations in the central surveyed area south of 61°S during January–February 1984 (Fig. 2). It is interesting to note that from the observation of 10 m depth isotherms the cold water masses were prevailing in the central area from pack ice margins during the same season (Fig. 4).

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## References

- ANDRIASHEV, A. P. (1965): A general review of the Antarctic fish fauna. *Monogr. Biolog.*, **15**, 491–555.
- ANDRIASHEV, A. P. (1980): First finding of the families Zoarcidae and Liparidae near Kerguelen Island. *Sov. J. Mar. Biol.*, **5**, 481–486.
- DEWITT, H. H. (1971): Coastal and Deep-Water Benthic Fishes of the Antarctic. New York, Am. Geogr. Soc., 10 p. (Antarctic Map Folio Series, Folio 15).
- DUHAMEL, G., HUREAU, J.-C. and OZOUF-COSTAZ, C. (1983): Ecological survey of the notothenioid fishes in the Southern Ocean from Bouvet to Kerguelen Islands. *Mem. Natl Inst. Polar Res., Spec. Issue*, **27**, 176–181.
- EFREMENTKO, V. N. (1983): Atlas of fish larvae of the Southern Ocean. *Cybium*, **7**, 1–74.
- EVERSON, I. (1977): The Living Resources of the Southern Ocean. Southern Ocean Fisheries Survey Programme GLO/SO/77/1, Rome, FAO, UNDP, 156 p.
- GULLAND, J. A. (1983): The development of fisheries and stock assessment of resources in the Southern Ocean. *Mem. Natl Inst. Polar Res., Spec. Issue*, **27**, 233–246.
- MEISNER, E. E. and KRATKII, V. E. (1978): New data on the distribution of Antarctic fishes. *Sov. J. Mar. Biol.*, **4**, 733–738.
- MIYA, M., OKIYAMA, M. and NEMOTO, T. (1986): Midwater fishes of the Southern Ocean south of Australia (extended abstract). *Mem. Natl Inst. Polar Res., Spec. Issue*, **40**, 323–324.
- NAFPAKTITIS, B. G. (1978): Systematics and distribution of lantern fishes of the genera *Lobinchia* and *Diaphus* (Myctophidae) in the Indian Ocean. *Nat. Hist. Mus. Los Angeles Cty., Sci. Bull.*, **30**, 1–92.
- NAFPAKTITIS, B. G. and NAFPAKTITIS, M. (1969): Lantern fishes (Family Myctophidae) collected during cruises 3 and 6 of the R/V Anton Bruun in the Indian Ocean. *Bull. Los Angeles Cty. Mus. Nat. Hist., Sci.*, **5**, 1–79.
- WILLIAMS, R. (1983): The inshore fishes of Heard and MacDonald Islands, southern Indian Ocean. *J. Fish Biol.*, **23**, 283–292.
- YUKOV, V. L. (1972): The range of fish of the genus *Dissostichus* (Family Nototheniidae) in the Antarctic waters of the Indian Ocean. *J. Ichthyol.*, **12**, 346–347.

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